

BOISE CASCADE'S WEST TACOMA MILL (STEILACOOM)
CLASS II INSPECTION
AUGUST 24-26, 1989

by
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Water Body No. WA-PS-0080
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INTRODUCTION

A Class II inspection was conducted at Boise Cascade's (BC's) West Tacoma Mill in Steilacoom on April 24-26, 1989. The inspection was requested by Ecology's Industrial Section. Don Reif and Keith Seiders of Ecology's Environmental Investigations Section, Compliance Monitoring Unit conducted the inspection. Ken Campbell, Engineering Services Manager, and Skip Thompson with laboratory services provided assistance from Boise Cascade.

Objectives of the inspection are as follows:

- Assess plant compliance with NPDES permit parameters.
- Characterize effluent and outfall near-field sediment toxicity by chemical and bioassay testing.
- Review mill lab procedures for conformance with standard procedures.
- Provide baseline data for future inspections.

LOCATION AND DESCRIPTION

Boise Cascade is located at the mouth of Chambers Creek, just northeast of Steilacoom (Figure 1). The thermo-mechanical pulp mill produces 150,000 tons of newsprint annually. An average 4.8 MGD of process wastewater is treated in an aerated lagoon (aerated stabilization basin, or ASB) following primary clarification (Figure 2). Primary sludge is burned in the hog fuel boiler after being thickened in a press. Final effluent discharges to Puget Sound at about 35 feet MLLW through a 96 foot diffuser section about 350 feet from shore.

METHODS

Composite samples of the primary and final effluents were taken. Ecology's ISCO automatic samplers composited 400 mL every 30 minutes for 24 hours. Two compositors collected effluent samples. One was used for conventional samples only; the other was used for priority pollutant organic analyses. Effluent bioassay samples were a combination of automatic and grab composite samples due to the volume required. Also, grab samples were collected from primary influent and effluent, final effluent, and filter backwash from the process water treatment system. Composite samples were split between the mill and Ecology to assess interlaboratory correlation. The sampling schedule with sites and parameters is shown in Table 1. Sampling sites are shown on Figure 2.

Two near-field sediment samples were collected. Sediment sample #1 was taken from the north side of the diffuser's midpoint. Sediment

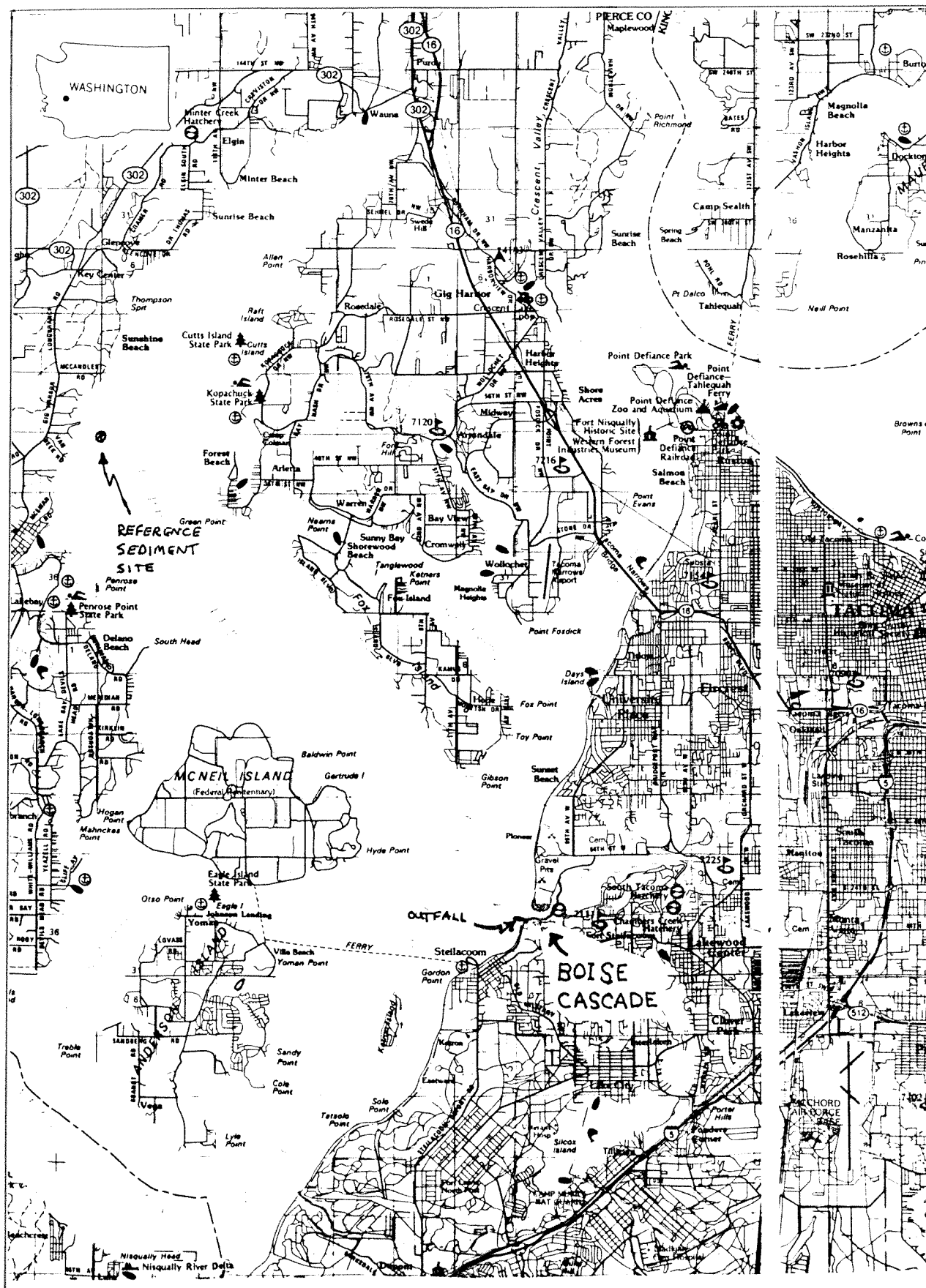


Figure 1. Plant location with outfall and reference sediment locations - Boise Cascade, Steilacoom Class II Inspection: April 24-26, 1989.

sample #2 was collected approximately 200 feet to the north of the diffuser, just outside the dilution zone as defined in the mill's permit. Also, a field reference sample was collected in Carr Inlet about nine miles northwest of the outfall. This site corresponds to Ecology's sediment ambient monitoring station #F43. Samples were collected with a 0.1 m² Van Veen clamshell sampler. Each of the three samples consisted of three grabs that were composited, homogenized, and subsampled. Sampling procedures conformed to Puget Sound Protocols (Tetra Tech, 1986). Upon collection, all samples were immediately iced and delivered to Ecology's Manchester Lab within 24 hours. Most analyses were run by commercial laboratories. A listing of methods, references, and labs used for analytical work are shown in Appendix 4.

A doppler-type portable flowmeter was used to attempt to verify the accuracy of Boise Cascade's magnetic flowmeter. Ecology's meter was installed in the mill's effluent flowmeter vault, attached to the downstream side of the 20-inch pipe.

RESULTS AND DISCUSSION

Flow

The accuracy of BC's flowmeter was not assessed because Ecology's flowmeter failed during the night. BC's flowrate appeared to be quite constant during the inspection. One instantaneous check showed good correlation between the two meters. This flowmeter should be checked at the next inspection. BC's flowmeter total of 4.46 MGD is used in subsequent discussions and calculations.

General Conditions

Overall, BC's wastewater treatment system achieved significant reductions of BOD, COD, total solids, and total suspended solids: 84%, 81%, 44%, and 89%, respectively. Much of these reductions took place in the secondary part of the treatment process. An exception was final effluent suspended solids, which were 2.3 times greater than the primary effluent (150 mg/L versus 65 mg/L). This apparent anomaly is related to the ASB secondary treatment system at BC, which does not include a final clarifier.

NPDES Permit Compliance

All NPDES permit conditions were met during the inspection (Table 3). BOD and TSS were 54% and 57%, respectively, of the daily average limits. The trout bioassay had 93% survival at 65% effluent, well above the 80% minimum.

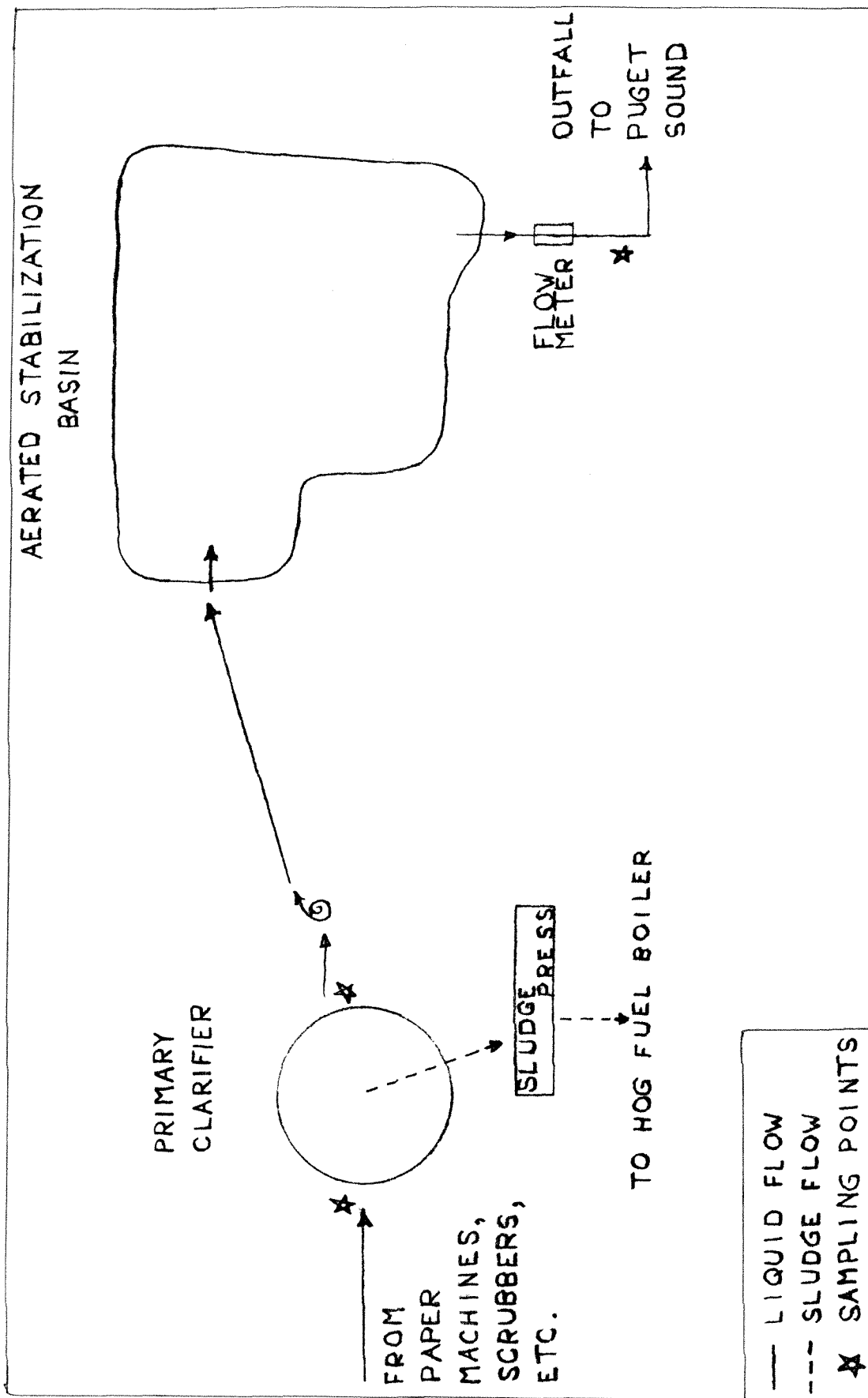


Figure 2. Flow schematic with sampling locations - Boise Cascade
Class II Inspection: April 24-26, 1989.

Effluent Bioassays

Various amounts of toxicity were found in the effluent bioassays (Table 4). Very little toxicity was indicated in all but two tests. The Microtox, fathead minnow, and *Daphnia magna* bioassays all had EC₅₀'s (concentration that adversely affects 50% of the test population) of greater than 100% effluent. Juvenile rainbow trout had a seven percent mortality at 65% effluent. The echinoderm and oyster larvae bioassays were, as is fairly typical, the most sensitive. For the echinoderm test, the effluent NOEC (No Observed Effects Concentration) was 3.0%, and the EC₅₀ was 18.8%. The salinity control, by contrast, had an NOEC of 12.5% and an EC₅₀ of 32.4%. An EC₅₀ of 9.7% effluent was estimated for the oyster bioassay. However, mortality data for both the sample and salinity control were highly variable and it was therefore impossible to calculate EC₅₀'s, NOEC's, and LOEC's for them. Abnormality data for the salinity controls indicated on NOEC of 1%, LOEC of 3.2%, and sufficient variability to make an EC₅₀ calculation impossible. The reason for the apparent toxicity in the salinity controls is unknown. Salinity should not have been a problem, even at the highest effluent concentration (18% with 31 ppt). Because of this, however, the oyster larvae results should be used only with great caution.

Effluent Chemistry

Several volatile and base/neutral organics and resin acids were detected in BC's final effluent, although most were found at relatively low concentrations. Acetone was detected at 290 ppb but may have been related to compositor cleaning solvents (Table 5). Several resin acids were detected in the effluent although the secondary treatment system reduced these compounds from 47 to greater than 95%. No guaiacols, polychlorinated biphenyls, or priority pollutant pesticides were detected in the primary or final effluents.

Several metals were detected in BC's effluent (Table 5). Of these, nickel, lead, and copper exceeded one or more of the freshwater and/or saltwater ambient criteria at the hardness level of the effluent (EPA 1986). However, only copper exceeded a criterion to any appreciable degree. Effluent copper was 3.5 and 5.3 times greater than the freshwater acute and chronic criteria, respectively, while the saltwater criterion was exceeded by 20 times. Therefore, a dilution factor of at least 20 in BC's mixing zone would be necessary to prevent an exceedance of water quality criteria.

A complete listing of the organics and metals analyses is found in Appendices 1 and 2.

Sediment Bioassays

Results of two bioassays (marine amphipod and Microtox) indicated no apparent toxicity in the two near-field outfall sediments or the reference site in Henderson Bay (Table 6).

Sediment Chemistry

Most of the priority pollutant organics detected in the sediment samples were found in sample #1 (Table 7). Of these, most were higher molecular weight (PAH's) polynuclear aromatic hydrocarbons. All organics were well below Ecology's criteria except for (PCB's) polychlorinated biphenyls. PCB's in sediment #1, collected near the outfall, were twenty-three times greater than Ecology's criterion (280 versus 12 mg/kg as organic carbon). Therefore, this sediment would be "predicted to have an adverse effect on Puget Sound biological resources" based on total PCB concentration (Betts, 1989). Following this evaluation process, however, this prediction can be overridden when biological testing indicates no toxic effect. The full biological testing needed to confirm or override the chemical data was not done; only one of the two acute tests (amphipod) in addition to the one chronic test (Microtox) were run. Of the available results, however, sediment #1 would have passed the biological portion of the testing since no adverse effects were noted.

Laboratory Evaluation

A review of lab procedures during the inspection indicated several areas of potential improvement to comply with accepted lab protocols. An earlier memorandum addressed the major concerns (Reif, 1989a). These included initial (zero day) D.O. determination in all BOD bottles, proper seed BOD determination and calculation, and proper TSS procedures.

Items not mentioned in the earlier memo are as follows:

- Compositing sample temperatures should be checked periodically to be sure that proper refrigeration is maintained (four degrees C.) during collection.
- Composite sampling lines should be rinsed with a chlorine solution every three months, or the hose replaced.
- For any D.O. determinations, the D.O. meter should be calibrated daily. For BODs, a minimum of 2.0 mg/L D.O. depletion and 1.0 mg/L D.O. remaining must be strictly adhered to.
- For the BOD incubator, a thermometer in a water bath is recommended to measure temperatures. Also, a certified

thermometer should be available to periodically check the accuracy of all thermometers.

- For TSS, an approved filter paper should be used, such as the Whatman 934AH. Filters need to be dried at least one hour, and the time period should be consistent.
- Dessicant in the dessicators must be maintained to preserve its effectiveness.
- A standard reference, such as Standard Methods, must be used consistently and completely.

Comparison of Sample Splits

Samples split between Boise Cascade and Ecology's labs showed good agreement for TSS, as shown in Table 8. In both BOD analyses, BC's BOD value was approximately twenty-five percent higher than Ecology's. Since many changes have occurred within BC's lab since the inspection, another set of splits may yield useful information.

SUMMARY AND RECOMMENDATIONS

BC's flowmeter appeared to be accurate but could not be confirmed due to mechanical failure of Ecology's portable flowmeter. The flowmeter should be rechecked during the next inspection.

BC was within all permitted discharge parameters during the inspection. Effluent suspended solids were high, but are related to the type of secondary treatment system used at BC.

Effluent biological toxicity did not appear elevated as measured by bioassays. Rainbow trout, fathead minnow, *Daphnia magna*, *Ceriodaphnia dubia*, and Microtox had EC₅₀'s greater than 100% effluent. The pacific oyster bioassay had an EC₅₀ of 9.7% effluent, but was clouded by a low apparent effect of salinity. The echinoderm bioassay had an EC₅₀ of 19% effluent. Both of these results are relatively mild compared to other pulp mill effluents (Reif, 1989b).

Several organics and metals were found at low concentrations in the final effluent. Only copper notably exceeded EPA's criteria for ambient water quality. A dilution factor of twenty would have been necessary to prevent an exceedance of water quality criteria in BC's mixing zone.

No measureable adverse effects were seen in the two sediment bioassays (Microtox and *Rhepoxinius abronius*). Of the priority pollutants detected in the outfall sediment samples, one--total PCBs--exceeded Ecology's proposed criterion for sediments. Since no adverse biological effect was apparent, this sediment would

probably not be classified under Ecology sediment guidelines.

Splits between the Ecology and BC's labs agreed well for TSS, but were marginal for BOD. From the lab evaluation, it was noted that BC's lab was not following approved protocols for the BOD and TSS tests. These items were noted in an earlier memo and in the Lab Evaluation section. Most of these concerns have all ready been addressed by BC's lab. Sample split evaluations are recommended for future Class II inspections.

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- Tetra Tech Inc.1986. Recommended Protocols for Measuring Selected Environmental Variable in Puget Sound, Final Report #TC-3991-04. March 1986.

TABLES

Table 1. Sampling schedule - Boise Cascade Class II inspection: April 24-26, 1989.

| | Water Samples | | | | | | | | | | | | Sediment Samples | | | | | |
|----------------------------------|--|------------------------------|------------------------------|----------------------------|------------------------------|------------------------------|----------------------------|------------------------------|------------------------------|----------------------------|------------------------------|-------------------------------|---------------------------|----------------------------|---------------------------|-------------------------|-------------------------|-----------------------|
| | Station: Date: Time: Type: Lab ID #: | P.Inf. 4/25 am grab | P.Eff. 4/25 am grab | Eff. 4/25 am grab | P.Inf. 4/25 pm grab | P.Eff. 4/25 pm grab | Eff. 4/25 pm grab | P.Inf. 4/26 am grab | P.Eff. 4/26 am grab | Eff. 4/26 am grab | F.B.W. 4/26 am grab | Cha.Ck. 4/26 pm grab | P.Eff. 4/25-26 comp | Eff-Eco 4/25-26 comp | Eff-BC 4/25-26 comp | Test #1 4/24 grab | Test #2 4/24 grab | Refer 4/24 grab |
| GENERAL CHEMISTRY | | | | | | | | | | | | | | | | | | |
| Turbidity | E | E | E | E | E | E | E | E | E | E | E | | E | E | E | | | |
| pH | E | E | E | E | E | E | E | E | E | E | E | | E | E | E | | | |
| Conductivity | E | E | E | E | E | E | E | E | E | E | E | | E | E | E | | | |
| Alkalinity | E | E | E | E | E | E | E | E | E | E | E | | E | E | E | | | |
| Hardness | | | | | | | | | | | | | E | E | | | | |
| Cyanide | | | | | | | | | | | | | E | E | | E | E | E |
| Solids(4) | E | E | E | E | E | E | E | E | E | E | E | | E | E,BC | E,BC | | | |
| BOD ₅ | E | E | E | E | E | E | E | E | E | E | E | | E | E,BC | E,BC | | | |
| COD | | E | E | E | E | E | E | E | E | E | E | | E | E | E | | | |
| Nutrients(4) | | | | | | | | | | | | | | | | | | |
| NH ₃ | E | E | E | E | E | E | E | E | E | E | E | | E | E | E | | | |
| NO ₃ +NO ₂ | E | E | E | E | E | E | E | E | E | E | E | | E | E | E | | | |
| T-Phosphate | E | E | E | E | E | E | E | E | E | E | E | | E | E | E | | | |
| Fecal Coliform | | | | | | | | | | | | | | | | | | |
| % Kleb | | | | | | | | | | | | | | | | E | E | E |
| % Solids | | | | | | | | | | | | | | | | E | E | E |
| Grain Size | | | | | | | | | | | | | | | | | | |
| ORGANICS + METALS | | | | | | | | | | | | | | | | | | |
| pp metals | | | | | | | | | | | | | | | | | | |
| ABN (water) | | | | | | | | | | | | | E | E | E | E | E | E |
| ABN (solids) | | | | | | | | | | | | | E | E | | E | E | E |
| VOA (water) | | | | | | | | | | E | | | | | | | | |
| Pest/PCB (water) | | | | | | | | | | | | | E | E | | | | |
| Pest/PCB (solids) | | | | | | | | | | | | | | | | E | E | E |
| Resin Acids/Guaiacol | | | | | | | | | | | | | E | E | E | E | E | E |
| Phenols | | | | | | | | | | | | | E | E | | | | |
| Grease & Oils | | | | | | | | | | E | E | | | | | | | |
| TOC | | | | | | | | | | | | | | | | E | E | E |

Table 1. Continued.

| Water Samples | | | | | | | | | | | | | | Sediment Samples | | | |
|---------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|------------------|---------|---------|--------|
| Station: | P.Inf. | P.Eff. | Eff. | P.Inf. | P.Eff. | Eff. | P.Inf. | P.Eff. | Eff. | F.B.W. | Cha.Ck. | P.Eff. | Eff-Eco | Eff-BC | Test #1 | Test #2 | Refer |
| Date: | 4/25 | 4/25 | 4/25 | 4/25 | 4/25 | 4/25 | 4/26 | 4/26 | 4/26 | 4/26 | 4/26 | 4/25-26 | 4/25-26 | 4/25-26 | 4/24 | 4/24 | 4/24 |
| Time: | am | am | am | pm | pm | pm | am | am | am | am | pm | | | | | | |
| Type: | grab | grab | grab | grab | grab | grab | grab | grab | grab | grab | grab | comp | comp | comp | grab | grab | grab |
| Lab ID#: | 178133 | 178134 | 178135 | 178136 | 178137 | 178138 | 178140 | 178139 | 178141 | 178146 | 178142 | 178143 | 178144 | 178145 | 178130 | 178131 | 178132 |
| BIOASSAYS | | | | | | | | | | | | | | | | | |
| Trout | | | | | | | | | | | | | | E | | | |
| Microtox | | | | | | | | | | | | | E | | E | E | E |
| Fathead Minnow | | | | | | | | | | | | | E | | | | |
| Pacific Oyster | | | | | | | | | | | | | E | | | | |
| Ceriodaphnia dubia | | | | | | | | | | | | | E | | | | |
| Echinoderm | | | | | | | | | | | | | E | | | | |
| Daphnia magna | | | | | | | | | | | | | E | | | | |
| Rhepoxinus abronius | | | | | | | | | | | | | | E | E | E | E |
| FIELD ANALYSES | | | | | | | | | | | | | | | | | |
| pH | E | E | E | E | E | E | E | E | E | E | E | E | E | E | | | |
| Temperature | E | E | E | E | E | E | E | E | E | E | E | E | E | E | | | |
| Conductivity | E | E | E | E | E | E | E | E | E | E | E | E | E | E | | | |

E - analysis by Ecology

BC - analysis by Boise Cascade

Table 2. General chemistry results- Boise Cascade Class II inspection: April 24-26, 1989.

| Sample: | P.Inf. | P.Eff. | Eff. | P.Inf. | P.Eff. | Eff. | P.Ef. | Eff. | Eff. | P.Eff. | Eff-Eco | Eff-BC | F.B.W. | Cha.Ck. |
|--|--------|--------|------|--------|--------|---------|-------|------|------|-----------|-----------|-----------|--------|---------|
| Type: | grab | grab | grab | grab | grab | grab | grab | grab | grab | comp | comp | comp | grab | grab |
| Date: | 4/25 | 4/25 | 4/25 | 4/25 | 4/25 | 4/25 | 4/26 | 4/26 | 4/26 | 4/25-26 | 4/25-26 | 4/25-26 | 4/26 | 4/26 |
| Time: | 1045 | 1040 | 1140 | 1605 | 1605 | 1540 | 1150 | 1020 | 1200 | 1000-0930 | 1000-0930 | 1000-0930 | 1350 | 1352 |
| Laboratory Analyses: | | | | | | | | | | | | | | |
| Turbidity (NTU) | 270 | 97 | 69 | 240 | 95 | 70 | 97 | 66 | | 96 | 68 | 62 | 4 | |
| pH (std. units) | 6.66 | 5.18 | 6.3 | 6.61 | 5.31 | 6.29 | 5.34 | 6.60 | | 5.38 | 6.46 | 6.47 | 7.00 | |
| Conductivity (umhos/cm) | 784 | 707 | 604 | 651 | 717 | 520 | 829 | 546 | | 759 | 587 | 549 | 136 | |
| Alkalinity (mg/L CaCO ₃) | 84 | 81 | 35 | 75 | 85 | 37 | 87 | 45 | | 81 | 38 | 40 | 54 | |
| Hardness (mg/L CaCO ₃) | | | | | | | | | | 105 | 90 | 86 | | |
| Cyanide, total (mg/L) | | | | | | | | | | <0.002 | <0.002 | | | |
| Total Solids (mg/L) | 2600 | 1400 | 850 | 2000 | 1300 | 790 | 1400 | 830 | | 1400 | 790 | 790 | 150 | |
| Total NV Solids (mg/L) | 630 | 530 | 370 | 530 | 490 | 420 | 580 | 390 | | 560 | 400 | 360 | 84 | |
| TSS (mg/L) | 1100 | 96 | 175 | 810 | 59 | 180 | 64 | 200 | | 65 | 150 | 140 | 10 | |
| TNVSS (mg/L) | 80 | 4 | 35 | 60 | 12 | 19 | <1 | <1 | | <1 | <1 | <1 | <1 | |
| BOD ₅ (mg/L) | | | | | | | | | | 500 | 95 | 81 | 5 | |
| COD (mg/L) | 2880 | 1250 | 529 | 2100 | 1120 | 479 | 1310 | 536 | | 1700 | 548 | 522 | 20 | |
| NH ₃ -N (mg/L) | 0.07 | 0.04 | 0.03 | 0.06 | 0.04 | 0.03 | 0.04 | 0.03 | | 0.04 | 0.03 | 0.02 | 0.01 | |
| NO ₃ +NO ₂ -N (mg/L) | | | | | | | | | | | | | | |
| T-Phosphate (mg/L) | | | | | | | | | | | | | | |
| Fecal Coliform (#/100 ml) | 7.7 | 5.4 | 3.0 | 5.4 | 5.4 | 3.2 | 8.6 | 3.6 | | NAR | NAR | NAR | NAR | |
| % KES | | | | | | >20,000 | | | | 6.0 | 3.3 | 3.1 | 0.11 | |
| % Solids | | | | | | 100 | | | | | | | | |
| Grease & Oils (mg/L) | | | | | | | | | 3.8 | | | | | |
| Field Analyses: | | | | | | | | | | | | | | |
| pH (std. units) | 6.74 | 5.62 | 6.68 | 6.77 | 5.63 | 6.76 | 5.70 | 7.40 | - | 5.67 | 6.79 | 6.87 | 7.07 | 7.57 |
| Temperature (°C) | 37.6 | 34.6 | 26.3 | 34.6 | 34.8 | 25.9 | 33.3 | 26.3 | - | 11.0 | 6.4 | 13.0 | 14.1 | 14.0 |
| Conductivity (umhos/cm) | 770 | 855 | 640 | 730 | 832 | 660 | 920 | 660 | - | 960 | 750 | 616 | 195 | 175 |

NAR - no analytical result

PNQ - present but not quantified

Table 3. Comparison of inspection results to NPDES permit limits - Boise Cascade Steilacoom Class II inspection: April 24-26, 1989.

| Parameter | Daily Average | Daily Maximum | Inspection Results |
|----------------------------|---|------------------|-----------------------|
| BOD ₅ : lbs/day | 6500 | 12,500 | 3500 |
| TSS: lbs/day | 9900 | 18,500 | 5600 |
| pH | 6.0-9.0 | | 6.68, 6.76, 7.40 |
| Trout Bioassay | >/= 80% survival at 65% effluent concentr. | | 93% survival |

Table 4. Effluent bioassay summary- Boise Cascade Class II Inspection:
April 24-26, 1989.

| 96-hour Rainbow trout (<i>Oncorhynchus mykiss</i>) | | Microtox | | |
|---|--------------------|--|------------------------|--|
| | <u>% Mortality</u> | EC50 (15 minutes at 15 deg. C): >100% sample | | |
| 65% Effluent | 7 | | | |
| Control | 0 | | | |
| | <u>NOEC</u> | <u>LOEC</u> | <u>EC₅₀</u> | |
| Fathead Minnow (<i>Pimephales promelas</i> - 7 day) | 50% | 100% | >100% (96 hr) | |
| <i>Ceriodaphnia dubia</i> (7 day) | 12.5% | 25% | >1000% (48hr) | |
| <i>Daphnia magna</i> (7 day) | 100% | >100% | >100% (48hr) | |
| Oyster Larvae (<i>Crassostrea gigas</i>) | <0.1% | 0.1% | 9.7% | |
| Echinoderm Sperm Cell Toxicity (Green Sea Urchin- <i>Strongylocentrotus droebachiensis</i>) | 3.0% | 6.0% | 18.8% | |

Table 5. Summary of influent and effluent organics and metals, with effluent metals compared to EPA criteria- Boise Cascade Class II inspection: April 24-26, 1989 (all units in ug/L).

| Sample: Type: Date: | Pri. Eff. composite 4/23-24/89 | Eff-Eco composite 4/23-24/89 | EPA Water Quality Criteria for protection of ambient water quality*: | | | |
|----------------------------------|--------------------------------------|------------------------------------|--|------------|----------|------------|
| <u>Priority pollutant metals</u> | | | FW Acute | FW Chronic | SW Acute | SW Chronic |
| Antimony | 1.6 | 1.0 | 9000 | 1600 | - | - |
| Arsenic | 1.2 | 8.1 | - | - | - | - |
| Chromium | 6 | 5 U | 1590 | 190 | 10,300 | - |
| Copper | 64 | 57 | 16.1 | 10.8 | 2.9 | 2.9 |
| Lead | 8.4 | 7.7 | 71.4 | 2.8 | 140 | 5.6 |
| Nickel | 20 | 20 | 1300 | 144 | 75 | 8.3 |
| Zinc | 88 | 70 | 107 | 96.9 | 95 | 86 |
| <u>VOA Compounds</u> | ug/L | ug/L | | | | |
| Methylene Chloride | 8.5 B | 73 B | | | | |
| Acetone | 60 | 290 K | | | | |
| Carbon Disulfide | 18 | 1.2 U | | | | |
| Chloroform | 1.3 | 1.1 M | | | | |
| Toluene | 1.5 | 0.8 U | | | | |
| <u>Phenols, Total</u> | 40 | 6 | | | | |
| <u>BNA Compounds</u> | | | | | | |
| Benzyl Alcohol | 4 J | 5 U | | | | |
| 4-Methylphenol | 10 | 1 U | | | | |
| 2,4-Dimethylphenol | 1 M | 2 U | | | | |
| Bis(2-Ethylhexyl)phthalate | 1 | 1 | | | | |
| <u>Resin Acids</u> | | | | | | |
| Pimaric Acid | 57 | 30 | | | | |
| Sandacopimaric Acid | 130 | 27 | | | | |
| Isopimaric Acid | 330 | 79 | | | | |
| Palustric Acid | 500 | 25 U | | | | |
| Dehydroabietic Acid | 460 | 85 | | | | |
| Abietic Acid | 290 | 68 | | | | |
| Neoabietic Acid | 1,100 | 87 | | | | |

U indicates compound was analyzed for but not detected at the given detection limit

J indicates an estimated value when result is less than specified detection limit

B This flag is used when the analyte is found in the blank as well as the sample. Indicates possible/probable blank contamination

M indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters

K quantitated value fell above the limit of the calibration curve

* - effluent hardness of 90 mg/L CaCO₃ used for hardness-dependent metals criteria.

Table 6. Sediment bioassay results- Boise Cascade Class II inspection:
April 24-26, 1989.

| Amphipod (<i>Rhepoxynius abronius</i>) | Mean Values +/- S.D. | | % Reburial ³ |
|---|--|------------------------|-------------------------|
| | Survival ¹ | Avoidance ² | |
| Sediment #1 | 19.2+/-0.4 | 0.9+/-2.1 | 100 |
| Sediment #2 | 18.4+/-1.8 | 0.8+/-2.2 | 100 |
| Reference | 18.2+/-0.8 | 0.5+/-0.9 | 99 |
| Lab Control ⁴ | 18.4+/-1.5 | 0.8+/-1.3 | 100 |
| Microtox (saline extraction) | Results: No measureable toxicity in any sample. | | |

¹ n=5; a value of 20.0 = 100%. There were no significant differences (p=0.05) between the test sediments and the control sediment, or between the reference and sediments #1 & 2.

² Number of amphipods on the surface per jar per day (out of a maximum of 20.0).

³ Percentage of surviving amphipods able to rebury in clean sediment and seawater within 1 hour after the 10 day exposure.

⁴ Negative control sediment collected from West Beach, Whidbey Island, the amphipod collection site.

Table 7. Sediment organics and metals compared to criteria- Boise Cascade Class II inspection: April 24-26, 1989. (dry weight basis)

| | Sample: Date: | Sed. #1 4/22/90 | Sed. #2 4/22/90 | Reference 4/22/90 | Interim Sed. Quality Criteria ¹ |
|--|------------------|--------------------|--------------------|----------------------|--|
| Cyanide, Total (ug/Kg) | | 0.029 | 0.026U | 0.032U | |
| <u>BNAs (ug/Kg)</u> | | | | | |
| Phenol | | 110J | 250 | 90U | 420 |
| 4-Methylphenol | | 57U | 49 | 44U | 670 |
| Phenanthrene | | 18J | 41U | 44U | |
| Fluoranthene | | 43J | 41U | 44U | |
| Pyrene | | 25J | 41U | 44U | |
| Benzo(a)Anthracene | | 14M | 41U | 44U | |
| Chrysene | | 24M | 41U | 44U | |
| Benzo(b&k)Fluoranthene | | 30M | 41U | 44U | |
| Benzo(a)Pyrene | | 16M | 41U | 44U | |
| <u>Pest/PCB Compounds (ug/Kg)</u> | | | | | |
| Aroclor-1254 | | 270 | 40U | 40U | |
| Aroclor-1260 | | 70 | 40U | 40U | |
| Total PCBs | | 340 (280*) | | | 12* |
| <u>Priority pollutant metals (mg/Kg)</u> | | | | | |
| Arsenic | | 3.75 | 3.95 | 2.49 | 57 |
| Chromium | | 23.4 | 20.8 | 10.7 | 260 |
| Copper | | 10.1 | 7.81 | 3.83 | 390 |
| Lead | | 6.8 | 5.0 | 3.2 | 450 |
| Mercury | | 0.05U | 0.05 | 0.05U | 0.41 |
| Nickel | | 20.0 | 18.9 | 8.6 | - |
| Zinc | | 34.9 | 27.5 | 13.3 | 410 |

U indicates compound was analyzed for but not detected at the given detection limit

J indicates an estimated value when result is less than specified detection limit

B This flag is used when the analyte is found in the blank as well as the sample.
Indicates possible/probable blank contamination

M indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters

K quantitated value fell above the limit of the calibration curve

¹ Betts, Brett 1989. Interim Sediment Quality Evaluation Process for Puget Sound.
Wash. St. Dept. of Ecology, October 1989.

* - expressed as mg/kg organic carbon (ppm carbon).

Table 8. Comparison of laboratory results- Boise Cascade Class II inspection: April 24-26, 1989.

| Sample | Sampler | Laboratory | BOD ₅ (mg/L) | TSS (mg/L) |
|--------------------------|---------|------------|----------------------------|---------------|
| Composites: Effluent: | Ecology | Ecology | 95 | 150 |
| | Ecology | BC | 87 | 204 |
| | BC | Ecology | 81 | 140 |
| | BC | BC | 75 | 198 |

APPENDICES

Appendix 1. Results of VOA, BNA, Pest/PCB and metal priority pollutant scans- Boise Cascade Class II inspection: April 24-26, 1989.

| | | | | | |
|----------------------------|-------------|-------------|------------------|------------------|------------------|
| Sample: | Pri. Eff. | Eff-Eco | Sed. #1 | Sed. #2 | Reference |
| Lab Log #: | 178143 | 178144 | 178130 | 178131 | 178132 |
| Type: | composite | composite | composite | composite | composite |
| Date: | 4/23-24/89 | 4/23-24/89 | 4/22/90 | 4/22/90 | 4/22/90 |
| <u>VOA Compounds</u> | <u>ug/L</u> | <u>ug/L</u> | <u>ug/Kg dry</u> | <u>ug/Kg dry</u> | <u>ug/Kg dry</u> |
| Chloromethane | 3.8U | 3.8U | | | |
| Bromomethane | 3.1U | 3.1U | | | |
| Vinyl Chloride | 2.0U | 2.0U | | | |
| Chloroethane | 3.3U | 3.3U | | | |
| Methylene Chloride | 8.5B | 73 B | | | |
| Acetone | 60 | 290 K | | | |
| Carbon Disulfide | 18 | 1.2U | | | |
| 1,1-Dichloroethene | 0.7U | 0.7U | | | |
| 1,1-Dichloroethane | 0.6U | 0.6U | | | |
| 1,2-Dichloroethene (total) | 0.8U | 0.8U | | | |
| Chloroform | 1.3 | 1.1M | | | |
| 1,2-Dichloroethane | 0.5U | 0.5U | | | |
| 2-Butanone | 6.2U | 6.2U | | | |
| 1,1,1-Trichloroethane | 0.6U | 0.6U | | | |
| Carbon Tetrachloride | 0.9U | 0.9U | | | |
| Vinyl Acetate | 3.1U | 3.1U | | | |
| Bromodichloromethane | 0.3U | 0.3U | | | |
| 1,2-Dichloropropane | 0.7U | 0.7U | | | |
| trans-1,3-Dichloropropene | 1.8U | 1.8U | | | |
| Trichloroethene | 0.6U | 0.6U | | | |
| Dibromochloromethane | 0.7U | 0.7U | | | |
| 1,1,2-Trichloroethane | 0.7U | 0.7U | | | |
| Benzene | 1.0U | 1.0U | | | |
| cis-1,3-Dichloropropene | 1.9U | 1.9U | | | |
| 2-Chloroethylvinylether | 2.7U | 2.7U | | | |
| Bromoform | 2.5U | 2.5U | | | |
| 4-Methyl-2-Pentanone | 3.5U | 3.5U | | | |
| 2-Hexanone | 3.2U | 3.2U | | | |
| Tetrachloroethene | 0.5U | 0.5U | | | |
| 1,1,2,2-Tetrachloroethane | 2.7U | 2.7U | | | |
| Toluene | 1.5 | 0.8U | | | |
| Chlorobenzene | 0.9U | 0.9U | | | |
| Ethylbenzene | 0.8U | 0.8U | | | |
| Styrene | 1.1U | 1.1U | | | |
| Total Xylenes | 1.8U | 1.8U | | | |
| Cyanide, Total | 0.002U | 0.002U | 29 | 26 U | 32 U |
| Phenols, Total | 40 | 6 | | | |

Appendix 1. Continued.

| | Sample: Lab Log #: | Pri. Eff. 178139 | Eff-Eco 178144 | Sed. #1 178130 | Sed. #2 178131 | Reference 178132 |
|-----------------------------|-----------------------|---------------------|-------------------|-------------------|-------------------|---------------------|
| | Type: | composite | composite | composite | composite | composite |
| | Date: | 4/23-24/89 | 4/23-24/89 | 4/22/90 | 4/22/90 | 4/22/90 |
| BNA Compounds | <u>ug/L</u> | <u>ug/L</u> | <u>ug/Kg dry</u> | <u>ug/Kg dry</u> | <u>ug/Kg dry</u> | |
| Phenol | 8U | 2U | 110J | 250 | 90U | |
| Bis(2-Chloroethyl)Ether | 1U | 1U | 57U | 41U | 44U | |
| 2-Chlorophenol | 1U | 1U | 57U | 41U | 44U | |
| 1,3-Dichlorobenzene | 1U | 1U | 57U | 41U | 44U | |
| 1,4-Dichlorobenzene | 1U | 1U | 57U | 41U | 44U | |
| Benzyl Alcohol | 4J | 5U | 280U | 210U | 220U | |
| 1,2-Dichlorobenzene | 1U | 1U | 57U | 41U | 44U | |
| 2-Methylphenol | 1U | 1U | 57U | 41U | 44U | |
| Bis(2-chloroisopropyl)ether | 1U | 1U | 57U | 41U | 44U | |
| 4-Methylphenol | 10 | 1U | 57U | 49 | 44U | |
| N-Nitroso-Di-n-Propylamine | 1U | 1U | 57U | 41U | 44U | |
| Hexachloroethane | 2U | 2U | 110U | 80U | 90U | |
| Nitrobenzene | 1U | 1U | 57U | 41U | 44U | |
| Isophorone | 1U | 1U | 57U | 41U | 44U | |
| 2-Nitrophenol | 5U | 5U | 280U | 210U | 220U | |
| 2,4-Dimethylphenol | 1M | 2U | 110U | 80U | 90U | |
| Benzoic Acid | 10U | 10U | 570U | 410U | 440U | |
| Bis(2-Chloroethoxy)Methane | 1U | 1U | 57U | 41U | 44U | |
| 2,4-Dichlorophenol | 3U | 3U | 170U | 120U | 130U | |
| 1,2,4-Trichlorobenzene | 1U | 1U | 57U | 41U | 44U | |
| Naphthalene | 1U | 1U | 57U | 41U | 44U | |
| 4-Chloroaniline | 3U | 3U | 170U | 120U | 130U | |
| Hexachlorobutadiene | 2U | 2U | 110U | 80U | 90U | |
| 4-Chloro-3-Methylphenol | 2U | 2U | 110U | 80U | 90U | |
| 2-Methylnaphthalene | 1U | 1U | 57U | 41U | 44U | |
| Hexachlorocyclopentadiene | 5U | 5U | 280U | 210U | 220U | |
| 2,4,6-Trichlorophenol | 5U | 5U | 280U | 210U | 220U | |
| 2,4,5-Trichlorophenol | 5U | 5U | 280U | 210U | 220U | |
| 2-Chloronaphthalene | 1U | 1U | 57U | 41U | 44U | |
| 2-Nitroaniline | 5U | 5U | 280U | 210U | 220U | |
| Dimethyl Phthalate | 1U | 1U | 57U | 41U | 44U | |
| Acenaphthylene | 1U | 1U | 57U | 41U | 44U | |
| 3-Nitroaniline | 5U | 5U | 280U | 210U | 220U | |
| Acenaphthene | 1U | 1U | 57U | 41U | 44U | |
| 2,4-Dinitrophenol | 10U | 10U | 570U | 410U | 440U | |
| 4-Nitrophenol | 5U | 5U | 280U | 210U | 220U | |
| Dibenzofuran | 1U | 1U | 57U | 41U | 44U | |

Appendix 1. Continued.

| | | | | | |
|-------------------------------|-------------|-------------|------------------|------------------|------------------|
| Sample: | Pri. Eff. | Eff-Eco | Sed. #1 | Sed. #2 | Reference |
| Lab Log #: | 178143 | 178144 | 178130 | 178131 | 178132 |
| Type: | composite | composite | composite | composite | composite |
| Date: | 4/23-24/89 | 4/23-24/89 | 4/22/90 | 4/22/90 | 4/22/90 |
| <hr/> | | | | | |
| <u>BNA Compounds</u> | <u>ug/L</u> | <u>ug/L</u> | <u>ug/Kg dry</u> | <u>ug/Kg dry</u> | <u>ug/Kg dry</u> |
| 2,4-Dinitrotoluene | 5U | 5U | 280U | 210U | 220U |
| 2,6-Dinitrotoluene | 5U | 5U | 280U | 210U | 220U |
| Diethyl Phthalate | 1U | 1U | 57U | 41U | 44U |
| 4-Chlorophenyl-Phenylether | 1U | 1U | 57U | 41U | 44U |
| Fluorene | 1U | 1U | 57U | 41U | 44U |
| 4-Nitroaniline | 5U | 5U | 280U | 210U | 220U |
| 4,6-Dinitro-2-Methylphenol | 10U | 10U | 570U | 410U | 440U |
| N-Nitrosodiphenylamine | 1U | 1U | 57U | 41U | 44U |
| 1,2-Diphenylhydrazine | 1U | 1U | 57U | 41U | 44U |
| 4-Bromophenyl-Phenylether | 1U | 1U | 57U | 41U | 44U |
| Hexachlorobenzene | 1U | 1U | 57U | 41U | 44U |
| Pentachlorophenol | 5U | 5U | 280U | 210U | 220U |
| Phenanthrene | 1U | 1U | 18J | 41U | 44U |
| Anthracene | 1U | 1U | 57U | 41U | 44U |
| Di-n-Butyl Phthalate | 1U | 1U | 57U | 41U | 44U |
| Fluoranthene | 1U | 1U | 43J | 41U | 44U |
| Pyrene | 1U | 1U | 25J | 41U | 44U |
| Butylbenzylphthalate | 1U | 1U | 57U | 41U | 44U |
| 3,3'-Dichlorobenzidine | 5U | 5U | 280U | 210U | 220U |
| Benzo(a)Anthracene | 1U | 1U | 14M | 41U | 44U |
| Chrysene | 1U | 1U | 24M | 41U | 44U |
| Bis(2-Ethylhexyl)phthalate | 1 | 1 | 57U | 41U | 44U |
| Di-n-Octyl Phthalate | 1U | 1U | 57U | 41U | 44U |
| Benzo(b&k)Fluoranthene | 1U | 1U | 30M | 41U | 44U |
| Benzo(a)Pyrene | 1U | 1U | 16M | 41U | 44U |
| Indeno(1,2,3-cd)Pyrene | 1U | 1U | 57U | 41U | 44U |
| Dibenzo(a,h)Anthracene | 1U | 1U | 57U | 41U | 44U |
| Benzo(g,h,i)Perylene | 1U | 1U | 57U | 41U | 44U |
| <u>Pest/PCB Compounds</u> | | | | | |
| alpha-BHC | 0.03U | 0.03U | 3.0U | 2.0U | 2.0U |
| beta-BHC | 0.03U | 0.03U | 3.0U | 2.0U | 2.0U |
| delta-BHC | 0.03U | 0.03U | 3.0U | 2.0U | 2.0U |
| gamma-BHC (Lindane) | 0.03U | 0.03U | 3.0U | 2.0U | 2.0U |
| Heptachlor | 0.03U | 0.03U | 3.0U | 2.0U | 2.0U |
| Aldrin | 0.03U | 0.03U | 3.0U | 2.0U | 2.0U |
| Heptachlor Epoxide | 0.03U | 0.03U | 3.0U | 2.0U | 2.0U |

Appendix 1. Continued.

| | Sample: Lab Log #: | Pri. Eff. 178143 | Eff-Eco 178144 | Sed. #1 178130 | Sed. #2 178131 | Reference 178132 |
|---------------------------------------|-----------------------|---------------------|-------------------|-------------------|-------------------|---------------------|
| | Type: | composite | composite | composite | composite | composite |
| | Date: | 4/23-24/89 | 4/23-24/89 | 4/22/90 | 4/22/90 | 4/22/90 |
| <u>Pest/PCB Compounds (continued)</u> | | | | | | |
| Endosulfan I | | 0.03U | 0.03U | 3.0U | 2.0U | 2.0U |
| Dieldrin | | 0.05U | 0.05U | 4.5U | 3.0U | 3.0U |
| 4,4'-DDE | | 0.05U | 0.05U | 4.5U | 3.0U | 3.0 |
| Endrin | | 0.05U | 0.05U | 4.5U | 3.0U | 3.0U |
| Endosulfan II | | 0.05U | 0.05U | 8.0U | 3.0U | 3.0U |
| 4,4'-DDD | | 0.09U | 0.09U | 9.0U | 6.0U | 6.0U |
| Endosulfan Sulfate | | 0.09U | 0.09U | 9.0U | 6.0U | 6.0U |
| 4,4'-DDT | | 0.06U | 0.06U | 6.0U | 4.0U | 4.0U |
| Methoxychlor | | 0.12U | 0.12U | 12U | 8.0U | 8.0U |
| Endrin Ketone | | 0.05U | 0.05U | 4.5U | 3.0U | 3.0U |
| alpha-Chlordane } | | 0.03U | 0.03U | 3.0U | 2.0U | 2.0U |
| gamma-Chlordane } | | 0.03U | 0.03U | 4.0U | 2.0U | 2.0U |
| Toxaphene | | 4.5U | 4.5U | 450U | 300U | 300U |
| Aroclor-1016 and 1242 | | 0.06U | 0.06U | 60U | 40U | 40U |
| Aroclor-1248 | | 0.06U | 0.06U | 60U | 40U | 40U |
| Aroclor-1254 | | 0.06U | 0.06U | 270 | 40U | 40U |
| Aroclor-1260 | | 0.06U | 0.06U | 70 | 40U | 40U |
| <u>Priority pollutant metals</u> | | | | | | |
| | | <u>ug/L</u> | <u>ug/L</u> | <u>mg/Kg dry</u> | <u>mg/Kg dry</u> | <u>mg/Kg dry</u> |
| Antimony | | 1.6 | 1.0 | 0.115U | 0.115U | 0.122U |
| Arsenic | | 1.2 | 8.1 | 3.75 | 3.95 | 2.49 |
| Beryllium | | 1U | 1U | 0.11U | 0.12U | 0.13U |
| Cadmium | | 2U | 2U | 0.22U | 0.24U | 0.25U |
| Chromium | | 6 | 5U | 23.4 | 20.8 | 10.7 |
| Copper | | 64 | 57 | 10.1 | 7.81 | 3.83 |
| Lead | | 8.4 | 7.7 | 6.8 | 5.0 | 3.2 |
| Mercury | | 0.1U | 0.1U | 0.05U | 0.05 | 0.05U |
| Nickel | | 20 | 20 | 20.0 | 18.9 | 8.6 |
| Selenium | | 2.0U | 2.0U | 0.22U | 0.24U | 0.25U |
| Silver | | 3U | 3U | 0.34U | 0.36U | 0.38U |
| Thallium | | 1.0U | 1.0U | 0.112U | 0.122U | 0.126U |
| Zinc | | 88 | 70 | 34.9 | 27.5 | 13.3 |

U indicates compound was analyzed for but not detected at the given detection limit

J indicates an estimated value when result is less than specified detection limit

B This flag is used when the analyte is found in the blank as well as the sample.
Indicates possible/probable blank contamination

M indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters

K quantitated value fell above the limit of the calibration curve

Appendix 2. Resin Acids & Guaiacols, with sediment general chemistry data- Boise Cascade
Class II inspection: April 24-26, 1989.

| | Sample: | Pri. Eff. | Eff-Eco | Sed. #1 | Sed. #2 | Reference |
|--------------------------------|------------|------------|------------|-----------|-----------|-----------|
| | Lab Log #: | 178143 | 178144 | 178130 | 178131 | 178132 |
| | Type: | composite | composite | composite | composite | composite |
| | Date: | 4/23-24/89 | 4/23-24/89 | 4/22/90 | 4/22/90 | 4/22/90 |
| Pimaric Acid | | 57 | 30 | 15 U | 75 | 13 U |
| Sandacopimaric Acid | | 30 | 27 | 8.5M | 100 | 13 U |
| Isopimaric Acid | | 330 | 79 | 16 M | 360 | 27 U |
| Palustric Acid | | 500 | 25 U | 300 U | 390 U | 270 U |
| Dehydroabietic Acid | | 460 | 85 | 38 | 470 | 13 U |
| Abietic Acid | | 290 | 68 | 15 U | 250 | 13 U |
| Neoabietic Acid | | 1,100 | 87 | 60 U | 210 | 54 U |
| Chloro Dehydroabietic Acid | | 40 U | 5.0U | 60 U | 78 U | 54 U |
| Dichloro Dehydroabietic Acid | | 20 U | 2.5U | 30 U | 39 U | 27 U |
| 1,2-Dimethoxybenzene | | 10 U | 1.3U | 15 U | 19 U | 13 U |
| 4,5-Dichlorodimethoxybenzene | | 20 U | 2.5U | 30 U | 39 U | 27 U |
| 4,5,6-Trichlorodimethoxybenzen | | 40 U | 5.0U | 60 U | 78 U | 54 U |
| Tetrachlorodimethoxybenzene | | 40 U | 5.0U | 60 U | 78 U | 54 U |
| % Solids | | | | 78 | 77 | 77 |
| TOC, % C, dry | | | | 0.12 | 0.55 | 0.24 |
| Grain Size (% , dry basis): | | | | | | |
| Gravel (>2mm) | | | | 3 | 3 | <2 |
| Sand (2mm-62um) | | | | 89.8 | 96.2 | 98.9 |
| Silt (62um-4um) | | | | 7.2 | 0.7 | 0.9 |
| Clay (<4um) | | | | <0.1 | 0.1 | 0.2 |

U - indicates compound was analyzed for but not detected at the given detection limit

M - indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters

Appendix 3. Effluent bioassay results - Boise Cascade Class II Inspection: June 24-26, 1989.

96-hour Rainbow trout (*Oncorhynchus mykiss*)

| | # of live test organisms: | | Percent Mortality |
|-----------|---------------------------|--------------|----------------------|
| | <u>Initial</u> | <u>Final</u> | |
| Effluent* | 30 | 28 | 7 |
| Control | 30 | 30 | 0 |

* - 65% effluent concentration

Fathead Minnow (*Pimephales promelas*) - 7 days

| Effluent test concentration: | # <u>exposed</u> | % <u>survival</u> | Mean Wt. per fish <u>(mg)</u> |
|---------------------------------|---------------------|----------------------|-------------------------------------|
| 0% (control) | 30 | 86 | 0.39 |
| 6.25% | 30 | 90 | 0.42 |
| 12.5% | 30 | 96 | 0.36 |
| 25% | 30 | 90 | 0.38 |
| 50% | 30 | 86 | 0.37 |
| 100% | 30 | 76 | 0.22 |

NOEC - 50.0%

LOEC - 100%

96 hr. LC₅₀ - >100%

Ceriodaphnia dubia (7 day)

| <u>Concentrations:</u> | Total # <u>Exposed</u> | Survival <u>%</u> | Mean # of Young per <u>Orig.Females</u> |
|------------------------|---------------------------|----------------------|---|
| Control | 10 | 100 | 20 |
| 6.25 % | 10 | 100 | 31 |
| 12.5 % | 10 | 90 | 26 |
| 25 % | 10 | 80 | 15 |
| 50 % | 10 | 90 | 12 |
| 100 % | 10 | 100 | 2.7 |

NOEC: 12.5%

LOEC: 25.0%

48hr. EC₅₀: >100%

Microtox

EC₅₀ (15 minutes at 15 deg. C): >100% sample

Appendix 3. Continued.

Echinoderm Sperm Cell Toxicity

Green Sea Urchin - *Strongylocentrotus droebachiensis*

| <u>Dilution</u> | <u>% Unfertilized Eggs</u> | | |
|--------------------|----------------------------|-------------------------|-------------------|
| | <u>Effluent</u> | <u>Salinity Control</u> | <u>Seawater +</u> |
| 0.1% | 6.6 | 2.5 | |
| 1% | 4 | 20 | |
| 3% | 8 | 1 | |
| 6% | 12 | 12 | |
| 12.5% | 17 | 13 | |
| 25% | 80 | 21 | |
| 50% | 100 | 98 | |
| 100% | - | - | 4.7 |
| NOEC: | 3 % | 12.5 % | |
| LOEC: | 6 % | 25 % | |
| EC ₅₀ : | 18.8 % | 32.4 % | |

* - mean of three replicates

** - seawater diluted with deionized water

+ - negative control

Daphnia magna (7 days)

| <u>Concentrations:</u> | <u>Total # Exposed</u> | <u>Survival %</u> | <u>Mean # of Young per Orig. Females</u> |
|------------------------|------------------------|-------------------|--|
| Control | | 10 | 100181%1010021 |
| 3% | 10 | 90 | 24 |
| 10% | 10 | 100 | 31 |
| 30% | 10 | 100 | 28 |
| 100% | 10 | 100 | 17 |

NOEC: 100%

LOEC: >100%

48hr. EC₅₀: >100%

Appendix 3 Continued.

Oyster Larvae (*Crassostrea gigas*)

| Sample | Sample | | Salinity Control + | |
|--------------------|---------------------|--------------------------------|---------------------|--------------------------------|
| | Mean % Mortality | Weighted Mean % Abnormality | Mean % Mortality | Weighted Mean % Abnormality |
| 0 % (Control*) | 18 | 8.8 | - | - |
| 0.1 % | 17 | 15 | 15 | 14 |
| 0.5 % | 21 | 17 | 8.4 | 15 |
| 1 % | 5.6 | 24 | 11 | 16 |
| 3.2 % | 8.9 | 27 | 25 | 24 |
| 5.6 % | 12 | 35 | 9.9 | 19 |
| 10 % | 9.9 | 57 | 0 | 17 |
| 18 % | 24 | 99 | 18 | 21 |
| NOEC: | - | <0.1% | - | 1% |
| LOEC: | - | 0.1% | - | 3.2% |
| EC ₅₀ : | - | 9.7% | - | - |

* - dilution seawater control from Yaquina Bay, Oregon

+ - seawater plus distilled water

Equations:

$$\text{a) Mean Larval Mortality (\%)} = \frac{\text{Mean \# of Embryos Introduced} - \text{Mean \# of Larvae Surviving}}{\text{Mean \# Embryos Introduced}} \times 100$$

$$\text{b) Weighted Mean Larval Abnormality (\%)} = \frac{\text{\# Larvae Surviving in Replicate \#1}}{\text{\# Larvae Surviving in Replicates 1 \& 2}} \times \text{Larval Abnormality in Replicate 1 (\%)} + \frac{\text{\# Larvae Surviving in Replicate 2}}{\text{\# Larvae Surviving in Replicates 1 \& 2}} \times \text{Larval Abnormality in Replicate 2 (\%)}$$

where,

$$\text{Larval Abnormality (\%)} = \frac{\text{\# Abnormal Larvae}}{\text{\# Normal \& Abnormal Larvae}} \times 100$$

Appendix 4. Analytical methods- Boise Cascade Class II inspection: April 24-26, 1989.

| Laboratory Analyses | Method used for Ecology Analyses | Laboratory performing analysis |
|---------------------------------|--|---|
| Grain Size | Tetra Tech, 1986 | Laucks Testing Labs; Seattle, Wa. |
| % Solids | APHA, 1985: 209F | Laucks Testing Labs; Seattle, Wa. |
| TOC | APHA, 1985: 505 | Analytical Resources, Inc., Seattle Wa. |
| VOA (water) | EPA #624 | Analytical Resources, Inc., Seattle Wa. |
| VOA (solids) | EPA #8240 | Analytical Resources, Inc., Seattle Wa. |
| BNA (water) | EPA #625 | Analytical Resources, Inc., Seattle Wa. |
| BNA (solids) | EPA #8270 | Analytical Resources, Inc., Seattle Wa. |
| Pest/PCB (water) | EPA #608 | Analytical Resources, Inc., Seattle Wa. |
| Pest/PCB (solids) | EPA #8080 | Analytical Resources, Inc., Seattle Wa. |
| Resin Acids (water & solids) | NCASI, 1986 | Analytical Resources, Inc., Seattle Wa. |
| Metals | EPA #200 series | Analytical Resources, Inc., Seattle Wa. |
| Total Phenols | EPA #420.2 | Ecology; Manchester, Wa. |
| Cyanide | EPA #335.2-1 | Ecology; Manchester, Wa. |
| Trout 96-hour | Ecology, 1981 | Biomed Research Lab, Inc., Bellevue, Wa. |
| Microtox | Beckman (saline extraction) | Ecova, Redmond Wa. |
| <i>Daphnia magna</i> | EPA, 1987 | E.V.S. Consultants; Seattle, Wa. |
| Oyster larvae | ASTM E724-80, 1986 | E.V.S. Consultants; Seattle, Wa. |
| <i>Rhepoxinius</i> | Tetra Tech, 1986 | E.V.S. Consultants; Seattle, Wa. |
| Echinoderm Sperm Cell | Dinnel, <i>et al</i> , 1987 | E.V.S. Consultants; Seattle, Wa. |
| <i>Ceriodaphnia dubia</i> | EPA, 1985 | ERCE Bioassay Lab, San Diego Ca. |
| Fathead Minnow | EPA, 1985 | ERCE Bioassay Lab, San Diego Ca. |